

**SLIP COUPLING FOR PIPE,
AND METHOD OF USING A SLIP COUPLING IN PIPELINES
FOR COLLECTION LANDFILL GAS**

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TECHNICAL FIELD

[0002] This invention relates to couplings for pipe, and especially as may be employed in applications where pipe connections are required to
15 accommodate longitudinal movement along the axis of the pipe, such as elongation or contraction. Such apparatus is particularly well suited to gas gathering operations in sanitary landfill applications.

BACKGROUND

20 [0003] When pipes are employed in situations where movement may be experienced between components of a piping system, the piping system needs to be designed to accommodate such movement, in order to avoid excess stress, strain, or bending moment, which may result in premature failure of the piping

system. In one application, namely the collection of gas from sanitary landfills, the normally used plastic pipe products, such as high density polyethylene (HDPE), is subject to stress and strain from subsidence of the landfill mass below the surface of the landfill. Settlement, as well as temperature fluctuations, make design of piping systems for such applications problematic. The challenge of providing a safe, fluid tight, and sanitary environment for collection of gas from a landfill, has continued to require development of new apparatus and methods, especially to take advantage of bio-gas and route the same to an apparatus which can productively utilized such gas for the generation of heat and/or electrical or mechanical power. Currently, there is a great but as yet unmet need for systems that can easily accommodate telescoping of a pipe joint as the unstable landfill moves and settles, whether along a pipeline run or below a wellhead. Additionally, slip joints suitable for such a job could also find application for other utility applications, such as water or sewer pipe, or electrical conduit, where actual elongation or contraction is expected in normal operation and must be accommodated, or in applications where the potential for such movement must be included in the equipment installed, for example in connections between buildings and earthquake resistant/tolerant foundations. Consequently, this disclosure provides description of a novel slip coupling apparatus for pipe joints, and describes novel methods of employing such slip joints, such as in gas gathering piping in sanitary landfill applications.

BRIEF DESCRIPTION OF THE DRAWING

[0004] In order to enable the reader to attain a more complete appreciation of the invention, and of the novel features and the advantages thereof, attention is directed to the following detailed description when

5 considered in connection with the accompanying figures of the drawing, wherein:

[0005] FIG. 1 provides a front perspective view of one embodiment of a slip coupling apparatus taught herein, showing a first, smooth wall well pipe exiting the ground such as in a landfill, then a larger, outer casing which is provided and secured thereabove, as well as an outer casing backing flange that
10 is used to secure a flanged end (not visible, see FIG. 2) of the outer casing to a split ring, and a compression retainer which is utilized to secure the split ring circumferentially about the well pipe.

[0006] FIG. 2 provides an exploded perspective view of one embodiment for a slip coupling, showing the outer casing with flanged end, a outer casing
15 backing flange, an annular seal, one embodiment of a split ring, a gasket which is secured about a pipe by the split ring, and a compression ring used to secure the split ring about a pipe, as well as a plurality of fasteners.

[0007] FIG. 3 provides a top view, looking down at the embodiment of a suitable split ring that was first illustrated in FIG. 2.

20 [0008] FIG. 4 provides a vertical cross-sectional view of one embodiment for a slip coupling as taught herein, showing an outer casing with flanged end, an outlet casing backing flange, an annular seal, a split ring with gasket secured in

an annular groove, so that the smooth wall of a pipe may slide relative to the gasket by a distance L, as well as a plurality of suitable fasteners.

[0009] FIG. 5 provides a perspective view of another embodiment of a suitable split ring, which embodiment may be used in lieu of that first shown in
5 FIGS. 2 and 3; in this embodiment, the first split ring portion and the second split ring portion are identical, and may be easily matched for installation to secure a gasket.

[0010] FIG. 6 shows a perspective view of another embodiment of a slip coupling, here utilizing an integral outer casing flange, an annular seal for sealing
10 engagement between the integral outer casing flange and an obverse surface of one embodiment of a split ring, and also using a backing flange for the split ring.

[0011] FIG. 7 illustrates the embodiment first shown in FIG. 6, and shows the use of the integral outer casing flange, an annular seal, a slip ring with centered annular groove to accommodate a gasket which is sealed against a
15 pipe, a seal ring backing flange, and a plurality of fasteners to secure the components together to provide a pressurizable, leak tight joint.

[0012] FIG. 8 provides a perspective view similar to the embodiment just illustrated in FIGS. 6 and 7, but now showing the same components where the bolts used for fasteners are inverted as compared to the illustration provided in
20 FIG. 7.

[0013] FIG. 9 provides a still further embodiment of my slip coupling, here showing the use of an outer casing backing flange, a flanged end on the outer casing, an annular seal, a split ring with gasket, and a backing flange for the split

ring, with fasteners to secure the slip coupling in a leak tight configuration, as well as the use of the circumferential compression retainer around the slip ring.

[0014] FIGS. 10, 11, 12, and 13 provide further details of one embodiment of a suitable slip ring, showing the configuration provided in perspective view in FIG. 2. First, in FIGS. 10 and 11, the slip ring is shown with the first portion and the second portion joined in a closed, working position, and dimensions are provided as typical of one suitable configuration, and such dimensions should be considered illustrative and not limiting to the precise sizes depicted. Then, in FIGS. 12 and 13, the slip ring is shown with the first portion and the second portion separated in an open position.

[0015] FIG. 10 provides a top, plan view of the slip ring.

[0016] FIG. 11 provides a vertical cross-section view, taken across line 11-11 of FIG. 10.

[0017] FIG. 12 provides a top, plan view of the slip ring, now in a separated, open position.

[0018] FIG. 13 provides a vertical cross-section view of a slip ring, now in a separated, open position, taken across line 13-13 of FIG. 12.

[0019] FIG. 14 provides a top plan view of a outer casing backing flange, showing the fastener hole pattern that may be typically supplied to match the fastener hole pattern in a slip ring.

[0020] FIGS. 15, 16, 17, and 18 provide further details of another embodiment of a suitable slip ring, showing the configuration provided in perspective view in FIG. 5, where both the first ring portion and the second ring

portion are identical. First, in FIGS. 15 and 16, the slip ring is shown with the first portion and the second portion joined in a closed, working position, and dimensions are provided as typical of one suitable configuration, and such dimensions should be considered illustrative and not limiting to the precise sizes depicted. Then, in FIGS. 17 and 18, the slip ring is shown with the first portion and the second portion separated in an open position.

[0021] FIG. 15 provides a top, plan view of the slip ring.

[0022] FIG. 16 provides a vertical cross-section view, taken across line 16-16 of FIG. 15.

[0023] FIG. 17 provides a top, plan view of the slip ring, now in a separated, open position.

[0024] FIG. 18 provides a vertical cross-section view of a slip ring, now in a separated, open position, taken across line 18-18 of FIG. 17.

[0025] The foregoing figures, being merely exemplary, contain various elements that may be present or omitted from actual implementations and various configurations of a slip coupling which may be used for a variety of pipe joint situations, depending upon the circumstances. An attempt has been made to draw the figures in a way that illustrates at least those elements that are significant for an understanding of the various embodiments and aspects of the invention. However, various other elements of the unique slip coupling are also shown and briefly described to enable the reader to understand how various features, including optional or alternate features, may be utilized in order to provide a simple slip coupling for piping systems.

DETAILED DESCRIPTION

[0026] In many piping applications, it would be advantageous to provide a joint, and especially a fluid tight joint, that would enable a first pipe and a second pipe, such as may occur in gas gathering pipe, to move relative one to the other.

5 Such a joint is provided in the slip-coupling 20 illustrated in FIG. 1, where a pipe 22 having a longitudinal axis 24 and a smooth outer wall 26 is joined to an outer casing 40. As configured, the pipe 22 is substantially cylindrical with a pipe interior passageway 30 defined by interior wall 32 and a pipe upper end 34. The pipe upper end 34 is free to move within a casing interior passageway 36,
10 defined by interior casing wall 38 of outer casing 40, along longitudinal axis 24 by a preselected distance L. Thus, the casing interior passageway 36 is sized and shaped to fit therein at least some length of the pipe 22, so as to allow for expansion or contraction. For example, in typical landfill applications, the pipe upper end 34 may move downward in the direction of reference arrow 42, via
15 subsidence in the landfill, relative to a selected reference plan R. Alternately, as shown in FIG. 4, the pipe upper end 34 may move in a contraction fashion to a new location 34', rather than in the elongation fashion as just depicted in FIG. 1.

[0027] Further details of a first embodiment for a slip coupling 20 are depicted in FIG. 4. Here, the flange end 44 of outer casing 40 is shown. A split
20 ring 50, also shown in FIG. 3, is provided. The split ring 50 has first 50₁ and second 50₂ ring portions. The first 50₁ and second 50₂ ring portions each have an interior wall, 50W₁, and 50W₂, respectively. The interior walls 50W₁ and 50W₂ each include at least one gasket seat 52₁ and 52₂, respectively. A gasket 54 is

provided, in one embodiment in the form of a continuous ring gasket 54 as shown in FIGS. 2 and 5, which is located by the gasket seat 52 formed by in inner walls 50W₁, and 50W₂ by gasket seat portions 52₁ and 52₂, respectively. Gasket 54 is adapted to slidably receive the smooth outer wall 26 of the pipe 22 and to provide a fluid tight seal between the split ring 50 and the smooth outer wall 26 of the pipe 22.

[0028] The gasket 54 can be made of a resilient material having a coefficient of friction sufficiently low that the gasket 54 remains seated during sliding movement of the gasket 54 over said smooth outer wall 26 of the pipe 22.

Of course, such necessary characteristics may vary depending upon the size and shape of the gasket seat, the size and shape of the gasket, and the material of construction of pipe 22. Slip couplings as taught herein are especially suited for applications where piping utilized is made of high density polyethylene (HDPE), but many other types of pipe, including stainless steel, aluminum, or other thermoplastic materials could be utilized for pipe 22. In any event, one suitable gasket 54 material useful for HDPE applications is a gasket 54 made of VITON[®] brand fluorolastomer (hexafluoropropylene-vinylidene) marketed by Dupont Dow Elastomers LLC of Wilmington, Delaware, USA. Functional equivalents from other vendors may be utilized for this or other specific applications, depending of course on the nature of the surface which moves relative to the gasket material. One commonly available functional equivalent is a FLUOREL[®] brand fluorolastomer marketed by 3M (Minnesota Mining and Manufacturing Company

of St. Paul, Minnesota, USA, or the current owner of the FLUOREL® brand, Dyneon LLC of Oakdale, Minnesota USA.

[0029] As shown in FIGS. 2 and 3, the first 50₁ and second 50₂ ring portions may be provided in an open position as seen in these two figures, wherein first 50₁ and second 50₂ ring portions open to allow their attachment to or removal from the pipe 22. By removal of selected fasteners 58 such as bolts 60 (having shafts 61) and companion nuts 62, (accompanied by upper 64 and lower 66 washers as may be easily determined by those of ordinary skill in the art), split ring 50 can be positioned in an open position, ready for attachment to or removal from pipe 22. Then by repositioning the first 50₁ and second 50₂ split ring portions, and then tightening fasteners 58, the split ring can be secured in a closed position wherein said first 50₁ and second 50₂ split ring portions are secured in close fitting engagement around pipe 22, and in particular, positioned so as to bring gasket 54 in to sealing circumferential engagement with the smooth outer surface 26 of pipe 22.

[0030] As seen in FIGS. 1, 2, and 4, a compression retainer 60 can be provided, where the compression retainer 70 circumferentially confines the split ring 50 against radially outward movement. In one embodiment, the compression retainer 70 is provided in the form of an adjustably tightenable substantially circular metallic band. As further detailed in FIG. 2, in one embodiment, a suitable compression retainer 70 may be provided in the form of a pair of substantially semi-circular metallic band portions 72 and 74, which semi-circular metallic band portions have opposing attachment ear portions 76. The

opposing attachment ear portions securable each toward the other by adjustably
tightenable fasteners 78, which may be provided in the form of bolt 80 and nut
82.

[0031] In one embodiment, as seen in FIGS. 1, 2, and 4 the outer casing
5 40 is provided with a flanged end 41, and an outer casing backing flange 92 is
provided, sized and shaped for close fitting engagement over the flanged end 41
of the outer casing 40. In the embodiment illustrated in FIG. 14, the outer casing
backing flange 41 has eight apertures 100 for bolt holes, each defined by an
aperture edge wall portion 102. The eight apertures 100 are, in the embodiment
10 shown in FIG. 14, spaced equally angularly apart, or, in other words, forty five
degrees (45°) angularly apart.

[0032] Generally, the first 50₁ and second 50₂ ring portions, when in a
closed position, form a split ring 50 having a substantially annular ring shape
which extends between an outer wall 94 (having outer wall portions 94₁ and 94₂),
15 and the interior wall 50W, made up of inner wall portions 50W₁ and 50W₂. The
split ring 50 also normally includes a plurality of longitudinally extending bolt
through apertures defined by bolt hole interior walls 96.

[0033] Also, the outer casing backing flange 92 includes a plurality of
fastener through apertures 100, wherein each fastener through aperture is
20 defined by an aperture edge wall portion 102. The shaft portions 61 of
fasteners 58 are sized and shaped for fitting through one of the fastener through
apertures 100 in the outer casing backing flange 92 and through a companion
axially aligned bolt through aperture 96 in the split ring 50. At least one, and in

most embodiments, a plurality, and in the embodiments shown, eight through apertures 100 are utilized, and thus eight fasteners 58 are utilized. The fasteners 58 are adjustably tightenable to secure the outer casing backing flange 92 and the split ring 50 each toward the other.

5 [0034] Turning now to FIGS. 2, 4, 11 and 13, the gasket seat 52 can be provided, in one embodiment, in the form of a recess or annular groove 110 in the interior sidewall 50W of said first 50₁ and second 50₂ ring portions. In the embodiment shown in FIG. 11, the annular groove 110 is spaced in a centered relationship between the obverse side 112 and the reverse side 114 of the split
10 ring 50. More particularly, in the embodiment depicted in FIG. 11, the annular groove 110 has a height H_A extending between a lower groove side 116 and an upper groove side 118. In one embodiment, a groove 110 height H_A of about one half inch (0.5") in height and of about one quarter inch (0.25") in depth has been found adequate, in an application where the overall split ring has a total
15 height of about one and one-half inches (1.5"). In some designs, the first 50₁ and second 50₂ ring portions have an upper interior body portion 120₁ and 120₂, respectively, above the upper groove side 118, and a lower interior body portion 1221 and 1222, respectively, below the lower groove side 116. As shown in the embodiment depicted in FIG. 11, the upper interior body portions 120₁ and 120₂
20 extend between the obverse side 112 of the first 50₁ or second 50₂ split ring portion and said upper groove side 118 of the annular groove 110, and the upper interior body portion 120₁ or 120₂ has a thickness H_I equal to height H_A of the annular groove. Likewise, with equidistant spacing, the lower interior body

portion 122₁ or 122₂ extends between the reverse side 114 of the first 50₁ or the second 50₂ split ring portion and the lower groove side 116 of the annular groove 110, and wherein the lower interior body portion 122₁ or 122₂ has a thickness H_L equal to height H_A of the annular groove 110.

5 [0035] Returning now to FIGS. 6 and 7, in one embodiment, the outer casing 40 is provided with an integral outer casing flange 130 of width W₁₃₀ sufficient to provide, along a longitudinal axis, a plurality of fastener holes 132 defined by flange interior hole edge walls 134. In any event, flange 41 as shown in FIG. 2, or flange 130 as shown in FIG. 6, has a flange face portion 41F or
10 130F, respectively against which a resilient annular seal 140 is compressed. The annular seal 140 is sized and shaped for sealing engagement with and compression between the selected flanged face portion (41F or 130F) and the obverse side 112 of the split ring 50.

 [0036] For additional stability, a split ring backing flange 150 can be
15 provided. As seen in FIGS. 6 and 7, the split ring backing flange 150 is sized and shaped for close fitting, secured engagement against the split ring 50, where the positioning can be secured via fasteners 58. In such event, the split ring backing flange 150 has a plurality of fastener through apertures 152, each of which are defined by an aperture edge wall portion 154. The shaft portions 61 of
20 the fasteners are sized and shaped for fitting through one of the fastener through apertures 152 in the split ring backing flange 150, and through a companion axially aligned bolt 60 through aperture defined by edge wall 96 in the split ring 50. As noted above, at least one, and in most embodiments, a plurality, and in

the embodiments shown, eight through apertures 152 are utilized, and thus eight fasteners 58 are utilized. The fasteners 58 are adjustably tightenable to secure the split ring backing flange 150 and the split ring 50 each toward the other.

[0037] For many applications an outer casing 40 can be provided in high
5 density polyethylene, which, for example is commonly utilized in landfill gas gathering applications. Likewise, in such applications, the split ring 50 can be made from high density polyethylene. And similarly, in such cases it is often useful to provide the split ring backing flange 150 in high density polyethylene. However, those of ordinary skill in the art and to which this specification is
10 directed will recognize that alternate materials are sometimes necessary or desirable. For example, an outer casing backing flange 92 can be provided in ductile iron, or in an another suitable material for a specific service requirement or cost objective.

[0038] As seen in FIGS. 2, 6, and 10-13, the split ring 50 can in one
15 embodiment be provided with obverse side 112 and reverse side 114 which are identical. Alternately, as seen in FIGS. 5, and 15-18, in another embodiment 50B for a split ring, the obverse side 112' and the reverse side 114' are not identical, but, rather, the obverse side 112' matches, identically, the reverse side 114' of a companion flange suitable for mating engagement. In either case, whether with
20 split ring 50 or with split ring 50B, each one of the split ring portions 50₁ and 50₂, or 50B₁ and 50B₂, has a pair of ear portions E. Each ear portion E has a face portion E_F adapted for matching engagement with a matching face portion E_F of another split ring portion.

[0039] As can be seen in FIGS. 2 and 10, in one embodiment, an outer upper end wall 160 of first split ring portion 50₁ fits in close fitting matching engagement with inner upper end wall 162 of second split ring portion 50₂. And, inner upper end wall 164 of first split ring portion 50₁ fits in close fitting matching engagement with outer upper end wall 166 of second split ring portion 50₂. In the same embodiment, an outer lower end wall 170 of first split ring portion 50₁ fits in close fitting matching engagement with inner lower end wall 172 of second split ring portion 50₂. And, inner lower end wall 174 of first split ring portion 50₁ fits in close fitting matching engagement with outer lower end wall 176 of second split ring portion 50₂.

[0040] Similarly, in an alternate embodiment as seen in FIGS. 5, and 15-18, a first upper end wall 180 of first split ring portion 50B₁ fits in close fitting matching engagement with first outer upper end wall 182 of second split ring portion 50B₂. And, second upper end wall 184 of first split ring portion 50B₁ fits in close fitting matching engagement with second outer upper end wall 186 of second split ring portion 50B₂. In the same embodiment, a first outer lower end wall 190 of first split ring portion 50B₁ fits in close fitting matching engagement with first inner lower end wall 192 of second split ring portion 50B₂. And, second lower end wall 194 of first split ring portion 50B₁ fits in close fitting matching engagement with second inner lower end wall 196 of second split ring portion 50B₂.

[0041] As shown in FIGS. 5 and 15-18, split ring portions 50B₁ and 50B₂ can be provided where each has a first arc portion 200₁ and 200₂, respectively,

on the obverse side 112' having a first thickness H_I on one side of the gasket seat 52₁ or 52₂, respectively, and a second arc portion 202₁ and 202₂ on the reverse side 114' having a second thickness of H_L on a longitudinally opposite side of the gasket seat 52₁ or 52₂, respectively. As shown, first arc portion 200₁ is less than one hundred eighty degrees (180°) degrees, and said second arc portion 202₁ is more than one hundred eighty degrees (180°). And, in matching angular fashion, first arc portion 200₂ is less than one hundred eighty degrees (180°) degrees, and said second arc portion 202₂ is more than one hundred eighty degrees (180°). In one suitable embodiment, the first arc portion 200₁ of the first split ring portion 50B₁ is one hundred fifty degrees (150°), and the second arc portion 202₁ is two hundred ten degrees (210°). In the same embodiment, in the second split ring portion 50B₂, the first arc portion 200₂ is two hundred ten degrees (210°), and the second arc portion 202₂ is one hundred fifty degrees (150°).

Alternately, in the embodiment shown in FIGS. 2, 3, and 10-13, the split ring portions 50₁ and 50₂ each have a first arc portion 210₁ and 210₂, respectively, on the obverse side 112 having a first thickness H_I on one side of the gasket seat 52₁ or 52₂, respectively, and a second arc portion 212₁ and 212₂ on the reverse side 114 having a second thickness of H_L on a longitudinally opposite side of the gasket seat 52₁ or 52₂, respectively. As shown, first arc portion 210₁ is one hundred eighty degrees (180°) degrees, and said second arc portion 212₁ is one hundred eighty degrees (180°). However, the first arc portion 210₁ is offset from the second arc portion 212₁ by a preselected angle alpha (α).

And, in matching angular fashion, first arc portion 210₂ is offset from second arc portion 2121 by the same preselected angle alpha (α). As shown, one suitable angle alpha (α) has been found to be about thirty degrees (30°).

With the various components have been described in detail, it is easy to
5 understand how a piping structure can be manufactured which incorporates the slip coupling 20 described herein to allow a smooth wall pipe 22 to expand or contract relative to a suitable outer casing 40. I have found that a slip coupling manufactured according to the teachings herein can be used for containment of
10 pressurized fluids, and in particular, pressurized gases. In fact, a pressurizable fluid seal is provided which can easily be used for service up to about one hundred and fifty (150) pounds of fluid pressure, such as pressurized gas. Such a configuration can easily be used for rather long expansion, or subsidence situations, as encountered in landfill gas applications. For example, the slip coupling 20 is slidable along a preselected length L of pipe 22, which length may
15 easily be configured for a change of at least two (2) feet. By use of the same techniques as taught herein, and normal piping supports as known by those of ordinary skill in the art, a length of change in length L of at least 10 feet can be accommodated. In some applications, and again especially for landfill situations, it is expected that a change in length of at least forty (40) or more feet can be
20 accommodated. Thus, the slip coupling provided herein allows the easy, leak tight connection to well head piping in a landfill gas gathering situation, or in other utility line connections.

[0058] Although various aspects and elements of the invention are herein disclosed for illustrative purposes, it is to be understood that the slip coupling for pipe, and the method of use of the slip coupling in landfill gas gathering systems, are important improvements in the state of the art of devices and methods for piping joints. Although only a few exemplary aspects have been described in detail, various details are sufficiently set forth in the figures of the drawing and in the specification provided herein to enable one of ordinary skill in the art to make and use the invention(s), which need not be further described by additional writing in this detailed description. Importantly, the aspects and embodiments described and claimed herein may be modified from those shown without materially departing from the novel teachings and advantages provided as described herein, and may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. It is especially pointed out that the size, and extent of movement of a pipe relative to an outer casing, or the length of a slip coupling to accommodate an anticipated degree of movement, and the precise shape of the apparatus suitable for a specific situation, will vary widely based on the nature of the physical situation and the fluids being handled. Therefore, the embodiments presented herein are to be considered in all respects as illustrative and not restrictive. As such, this disclosure is intended to cover the structures described herein and not only structural equivalents thereof, but also equivalent structures. Numerous modifications and variations are possible in light of the above teachings. For example, the various piping components, including pipe, outer casing, backing rings, split rings, or backing

rings for split rings, may, for a particular service requirement, be made of may materials, including (a) high density polyethylene, (b) an aluminum alloy, (c) stainless steel, (d) brass, (e) carbon steel, (f) polyvinyl chloride, or (g) a moldable reinforced composite material. It is therefore to be understood that within the

5 scope of the appended claims, the invention(s) may be practiced otherwise than as specifically described herein. Thus, the scope of the invention(s) is as described herein and as set forth in the appended claims, and as indicated by the drawing and by the foregoing description, is intended to include variations from the embodiments provided which are nevertheless described by the broad

10 interpretation and range properly afforded to the plain meaning of the language of the claims set forth below.